GARCIA RIVER INSTREAM MONITORING COMPONENT

SEDIMENT TRANSPORT CORRIDORS

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STC Protocol

The protocol termed Sediment Transport Corridors was innovated by Dr. Fred Euphrat of Forest Soil and Water, Inc., as referenced in the 1998 Garcia River Instream Monitoring Plan funded by CDF (Euphrat, 1998). A Sediment Transport Corridor (STC) is defined as a visible pathway whereby sediment can enter or is entering the surveyed stream channel. This STC survey on Garcia River Basin streams interpretted this definition to include observations of the following landscape features: (1) a corridor actually delivering sediment, observed as suspended sediment entering the surveyed stream, (2) a bare topographic area (landslide, landing, road) or crenulation (gully) entering the surveyed stream, (3) an alluvial fan deposited in the surveyed stream, (4) a bank failure within the surveyed stream, or lastly (5) a tributary entering the surveyed stream.

A note on terms: For the purposes of this report, the term "stream" was used to convey a surveyed channel within the Garcia River Basin. The term "tributary" was reserved to describe an incoming waterway to the surveyed stream to allow the author and reader to separate one meaning from the other.

Survey location

During the first step of implementing the Instream Monitoring Plan (IMP), contractor Linda Vance, doctoral candidate U.C. Davis, laid out three to four permanent plots along study reaches of 12 streams of the Garcia River Basin in 1998-99. The surveyed streams were South Fork, Fleming Creek, Lee Creek, North Fork, Rolling Brook, Whitlow, Inman, Allen Creek, Mill, Pardaloe, Blue Waterhole, and Horace's Cabin creeks. Plot lengths varied from 100-380 feet, increasing with the size of the tributary. The Sediment Transport Corridor (STC) Survey spanned plots 1-4 in each surveyed stream's study reach including the interplot distances. A map of the Garcia River Basin's surveyed streams are provided in Figure 2.

Field Methods

Surveying for STCs was initiated in January, 1999 following a dry winter between November 30 and Christmas. Stream reaches were surveyed during or recently following significant rainfall events (>1 inch precipitation) except in the case of tributaries whose access required crossing the mainstem Garcia. For these streams, field evaluations were delayed until the mainstem was safely wadable.

The on-the-ground strategy employed in collecting STC data was that recommended by Dr. Euphrat. Specifically, the procedure was to start at the bottom of plot 1 and walk the stream channel, proceeding upstream looking left and right until encountering a STC. Signs used to identify an STC included bare soil areas observed as landslides, bank failures, and gullies on hillslopes and streambanks; alluvial fans deposited near the stream or within the stream; or suspended sediment in tributaries or gullies that entered the stream channel within the surveyed reach (Euphrat, 1998 - personal communication). The Euphrat field form was slightly modified to include distance (feet) upstream from the bottom of the reach to the STC, and plot or interplot in which the STC was found. These modifications were made to facilitate relocation - assumed to be critical in future phases of the IMP. A single field form was completed for each STC identified (the slightly modified Euphrat sample form appendicizes this report).

Deviations from the Field Form

Dr. Euphrat suggested this survey focus on bare area rather than volume given his experience that volumes were problematic to determine accurately (Euphrat, 1998, personal communication). Therefore, depth was not recorded in many instances even though a blank exists on the field form for it. Comments intermittently recorded included diversion probability, delivery potential, restoration priority, and whether machine restoration was feasible.

Tributaries

Waterways entering the surveyed reach were recorded as "tributaries". On encountering clear running tributaries without alluvial fans, a "Natural" Sediment Source type was recorded. Other recorded information was limited to the upstream distance where their mouth was encountered, the upstream Right or Left bank position, and average wetted width, along with a sketch of the mouth in relation to the surveyed stream. Widths were recorded on all tributaries to enable discerning one from another (large creek versus a small one) but length and depth information was purposefully omitted. In general, tributaries were problematic in that they contained their own STCs within the separate but related sub-basin. If the tributary was running more turbid than the surveyed reach, it was explored to determine the source of the turbidity and its average wetted width was recorded. If the tributary appeared to have about the same turbidity as the surveyed reach, a brief exploration was made. This method effectively omitted potential STCs within the sub-basins of the surveyed reach's tributaries.

Crossings were discerned from tributaries by the presence of a road across a tributary by way of a culvert causing some sort of mass-wasting. Ditch reliefs were frequently culverted but were distributing water from a road, not a tributary.

Classifying STC Type and Source

The terms Landscape Void Type and Sediment Delivery Source were coined to facilitate discerning, respectively, what was seen on the landscape versus what source it was traced to. Landform Void Type was determined by classifying the general landscape form of the STC as Bank failure, Gully, Headcut (knickpoint), Landslide, or Tributary. The term "Landslide" included shallow and deep seated failures, slumps and slides, rotational slides, and all similarly related forms of mass-wasting. Sediment Sources responsible for generating an STC were determined by chasing the suspended sediment plume, topographic crenulation, or landslide upslope - either to the source or first road crossing. Explorations were confined to the limits of landowner access agreements. A diversion was defined as water estranged from its natural topographic downhill drainage, by the presence and slope of a road, onto topsoil. Water Diversion Potential was graded from "Yes" (absolutely), "Likely", "Maybe", or lack of evidence of suggesting a diversion. A rough sketch of the STC in relation to the source and stream surveyed was made onto the field form.

Data

Each STC was referenced by a single field form, except in cases when several of the same type occurred closely together or were directly related. Each surveyed stream reach's STCs were entered from field forms onto a spreadsheet and transformed into a single page of data (see appendix). Individual surveyed streams were code-referenced by numbers instead of their commonly known names to afford cooperating landowners with data privacy. This was a required element of the project in exchange for access. The code references to the individual streams are a confidential component to this and other IMP Baseline Surveys and will be critical when comparative data are collected in the future. A legend clarifying the alphanumeric symbols used in the STC spreadsheet are located in the Appendix.

Summary tables were prepared for STC Landform Void Type, STC Sediment Delivery Source, and Diversion Probability. Void Volumes should be construed as minimum values because 1-foot was entered as a default tin order to convert bare areas to volumes. Therefore, Bare Areas are more accurate than Volumes.

Results

Of 138 STCs recorded, Landscape Void Types encountered were distributed by occurrence (100%=138 STCs) as follows; 47 tributaries (34%), 38 gullies (28%), 26 bank failures (19%), 26 landslides (19%), and 1 headcut or knick-point (0.7%). Most tributaries were considered to be STCs themselves as well as having potential STCs within them. Tributaries were generally unexplored and so were assumed to have "Unknown" Sediment Delivery Sources (see Field Methods). Upon examining the Sediment Delivery Source summary table, the majority of Landscape Void Types appear to have Unknown sources. This is partly due to the identification of all tributaries as STCs with "Unknown" sources. Of 68 STCs classified as having "Unknown" source, 31 were such tributaries. The remaining 37 "Unknown" STC source types represent the number of actual STC landform voids for which no source could securely be identified. "Natural" sources describe the 6 clear running tributaries and 1 headcut knickpoint in the main channel being surveyed, considered natural recovery for a stream having only sub-surface drainage for many years.

All but 4 gullies were road related, generated from crossings, ditch relief drainage, or an inner gorge road sloughing into the creek and forming micro-catchments. Most bank failures had "Unknown" Sediment Delivery Sources and probably occurred naturally. About half of the landslides encountered were likely to have been caused by a road indicated by a whole road or fraction of a road in immediate uphill vicinity. The single Landslide Sediment Source was found atop a bank failure on a murky running stream. Three landing sources were identified; one upon a floodplain terrace causing concentration of water and a bank failure, a second instream landing up a short distance within a tributary, and the third atop a landslide. Ditch relief waters were frequently at the source of hillslope gullies.

In quantifying Sediment Sources, "Unknown" sources represented half the bare area encountered. Tributaries (potential STCs) purposefully contributed 0 of "bare area" (or volume). Direct road sources accounted for 28.5% of bare area. Ditch relief and crossings accounted for 2.2% and 11.2%, respectively, bringing the total road-related bare area encountered to 42%.

Diversion Probability absolute ("Yes") was predominantly associated with gullies having crossings or ditch relief at their Source. Gullying is frequently caused by an unnatural concentration of water allowed to run on topsoil (Author's personal observation). More subtle diversions were considered a "Likely" source of the gullied portions (fresh, bare earth with no riparian vegetation) of natural-looking tributaries (having a bedload and riparian corridor). Other "likely" diversions showed no surface connection to the landform Void Type but were present in the immediate uphill vicinity (perhaps having a subsurface connection). "Maybe" diversions were not explored due to limitations on landowner access.

Post-Survey Conclusions

Besides tributaries, most STCs in the Garcia River stream reaches surveyed were road and crossing-related landslides and gullies. Many were apparently caused by the road diverting a tributary or spring down the road rather than across it and back into its natural channel. The frequency of roads in these watersheds was high and often occurred on both sides of the creek as well as parallel, slope-traversing segments of the same road on up the hillslope. Many existing roads could not be traveled on by a vehicle either because their crossings had been eroded (best case) or because the road and parts of the hillslopes had given way to landsliding (worst case). With 2 exceptions, ditch reliefs were absolutely ("Yes"), or "Likely" water diversions. Ditch relief culverts and/or water bars have apparently caused many high-gradient gullies traveling vertically from road to channel. These were narrow in cross-section, and usually appeared dry - making them the least obvious STC type. They must pass water swiftly and erode during high intensity rainfall. In a few cases, inner gorge roads were barely discernible as roads because their fillslopes had delivered into the creek or gullies had cut back through them. There are multiple cases where road fills at crossings were washed out but the tributary remained or was once again connected because the road was constructed without diversion potential. While road fill at these sites may have deposited downstream, these crossings are likely to be in a natural state of rehabilitation with continued risk of fill failure unlikely.

Challenges and Recommendations for Future STC surveys

Walking the channel was an efficient method of locating STCs, classifying them, and determining their source through exploring connections uphill. Many hillslope processes may be viewed from the channel, however the channel offered a limited view of the watershed. Even in the lowest order tributaries STCs were discovered from the roads that were not encountered along the stream. It is likely that these would be found in a complimentary road survey, which is highly recommended. In third and fourth order tributaries, floodplains and terraces have developed to the extent that they redirected and absorbed STCs. In the largest streams surveyed, tributaries were difficult to locate because (1) they tended to flow along the mountainside (effectively concealing their canyon) rather than cutting through a flood terrace, or, because (2) they showed no surface expression, presumably entering the channel subsurfacely through the floodplain or terrace. Multiple passes including both valley walls would ensure all tributaries are identified, explored, rated, and recorded. It should be noted that when surveying STCs in low order drainages (1-3), the steeper gradients enable the stream to transport minor fans delivered by an incoming STC. In these Garcia River streams, the void was a more certain sign of an STC than was the deposit.

Given that adequate time is available, the STC survey allows the surveyor to view sediment transport in action, clearly determines the source and magnitude of delivered sediment upon upslope exploration, and provides a summary of what sorts of mass-wasting processes are dominant in the watershed. The dominant effect of roads and their associated crossings on channels was clearly evident from this field survey. Estimates of bare area were rough but rapid and provided a qualitative indication of the magnitude of erosion divided into categories.

Quantitative precision defining the landscape void could and should be improved when the goals of the survey depend on quantitative comparisons of eroded soil volume. Precise measurement of STC bare areas and volumes were impractical given the range of widths and depths exhibited in single STCs of Garcia River tributaries, especially with a solo-surveyor. Given the surveyor is familiar with hydrological and geological concepts, and is enabled with adequate time and a partner to hold the other end of a measuring tape, precision, accuracy, and safety would improve.

Preliminary STC surveys were completed without reference to distance. Potential relocatability of STCs in future surveys was improved by recording distance upstream to the STC from the bottom of the reach as well as plot number. Value of the STC survey might be further improved by sub-surveying all incoming tributaries and by associating STCs to mapped sources - sources perhaps previously mapped under the Mass-wasting component of the Watershed Assessment. A recent attempt at relocating identified STCs in one of the surveyed streams failed, but the relocation effort was made by a fisheries biologist without monitoring distances upstream. Future relocating efforts should be conducted by a surveyor trained in hydrology equipped with a distance recording device, such as a hipchain.

This STC survey is strong qualitatively and it is a price-performer. The Garcia STC survey was accomplished in one person-field-day per stream at a cost of 10-20% of the other survey protocols (cross-section and thalweg profile survey s, LWD, gravel composition/permeability). The improvements suggested could be implemented with 2 person days per stream in the field. Doubling the expense of this STC survey would bring its total cost to less than $10,000 or less than $1000 per surveyed tributary.

References Cited

Because this Sediment Transport Corridor protocol has been only recently developed, it has little history to draw on for the purposes of a report and related references.

Euphrat, Dr. Fred, Kull, K., M. O'Connor, and T. Gaman. 1998. Watershed Assessment and Cooperative Instream Monitoring Plan for the Garcia River, Mendocino County. Mendocino County Resource Conservation District for California Department of Forestry and Fire Protection. Sacramento, California.

Euphrat, Dr. Fred. 1998. Personal Communication with respect to converting what is seen in the field to STC field forms. See Forest, Soil, and Water, Healdsburg, CA.

Maahs, Michael. 1999. Personal Communication with respect to a field review of one post-STC survey. See Michael Maahs, Fort Bragg, CA.

O'Connor, Matt. 1998. Personal Communication with respect to a field review of one surveyed stream reach in the study area for peer review. See O'Connor Environmental, Healdsburg, CA.